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# Well Water Quality Assessed Based on Well Physical Condition, Distance, and Septic Tank Construction in Randuagung Village, Gresik

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## ABSTRACT

**Background** Well water remains the primary source of clean water for communities, but it is vulnerable to contamination due to human activities and inadequate sanitation conditions. **Object:** This study aims to assess the physical quality of well water by examining the construction conditions of the wells and the distance between the wells and septic tank structures in Randuagung Village, Gresik District. **Methods:** The study employs a qualitative method, an observational approach with a cross-sectional design. **Results:** The physical parameters analyzed include temperature, odor, and total dissolved solids (TDS) levels. Of the 11 samples tested, all failed to meet the physical quality standards for clean water as per Ministry of Health Regulation No. 2 of 2023. All samples showed TDS levels above 300 mg/L, and two samples were detected to have an abnormal odor. Although some wells met the standards for well physical conditions, septic tank construction, and safe distance from the septic tank, water quality remained poor. **Conclusion:** These findings indicate that the decline in well water physical quality is not caused by a single factor but is the result of a combination of well physical conditions, distance from pollution sources, and surrounding environmental factors.

**Keywords:** Physical quality of water, Dug wells, Septic tanks

## BACKGROUND

Access to clean water was a vital element in supporting human life, both for direct consumption and domestic needs such as bathing, washing, and cooking. As the population and standard of living increased, the demand for clean water rose significantly. According to WHO data, the average daily water requirement in developing countries such as Indonesia ranged from 30 to 60 liters per person per day. This condition underscored the importance of a reliable and sustainable clean water supply and management system (Rinancy & Puteri, 2021).

Based on the Ministry of Health Regulation No. 2 of 2023 on Environmental Health Quality Standards (SBMKL), water for domestic use had to meet physical quality requirements, namely being odorless, tasteless, and colorless (Kementerian Kesehatan, 2023). In many rural areas, dug wells remained the primary water source. However, many were constructed without adhering to environmental sanitation standards, particularly regarding construction and location. Wells that were not watertight, lacked protective edges, and were not equipped with permanent covers were more susceptible to physical water quality degradation, such as turbidity, odor, and color changes (Puteri, 2021).

Dug wells that did not meet technical requirements were generally more vulnerable to contamination from surface soil through seepage, especially since the available water originated from shallow soil layers. Therefore, well construction had to consider sanitation aspects, including maintaining a safe distance from pollution sources such as septic tanks. Septic tanks that were not built to standard, such as those that were not watertight, had the potential to contaminate groundwater due to leakage or seepage (Titaley, 2020). Wells located less than 15 meters from septic tanks experienced a significant decline in water quality, particularly in terms of turbidity, color, and total dissolved solids (TDS) (Ufoegbune et al., 2021). Furthermore, wells without structural protection such as concrete slabs and covers were more susceptible to changes in physical quality due to surface contamination (Genter et al., 2022).

A case study in Randuagung Village showed that most dug wells did not meet the construction specifications stated in SNI 03-2916-1992 (SNI & 03-2916-1992, 1992). The The well structures consisted only of stacked concrete pipes without cement plastering, making them non-waterproof. The distance between the well and the septic tank ranged from 5–8 meters, which failed to meet the minimum requirement of 10 meters. Additionally, the septic tanks had floors directly in contact with the ground and unplastered walls, allowing seepage. Residents reported odor and color changes in well water. This condition indicated that non-standard well construction could facilitate the entry of pollutants into the water source and reduce its physical quality. Similar findings were observed in wells without structural protection and those built at lower elevations than pollution sources, which experienced more noticeable changes in color and odor (Puteri, 2021).

Based on this background, this study aimed to analyze the physical quality of dug wells in relation to well condition, distance from septic tanks, and septic tank construction. The observed physical parameters included odor, temperature, and total dissolved solids (TDS). This study also evaluated the technical suitability of dug wells and septic tanks with applicable standards to identify potential sources of water pollution.

## RESEARCH METHODS

The research was conducted on 11 dug wells located in Randuagung Village, Kebomas Subdistrict, Gresik Regency. The wells were selected purposively based on accessibility and suspected vulnerability to contamination. This study assessed several physical aspects related to well water quality, including the physical condition of the wells (such as the presence or absence of plastered walls, depth and floor construction, covering structure, and the height of the well mouth), the construction of septic tanks (based on materials used, such as stacked concrete rings without plaster, floor permeability, and waterproofing status), and the distance between wells and septic tanks, which was measured using a measuring tape and compared to the minimum 10-meter safe distance standard (SNI & 03-2916-1992, 1992).

Water quality parameters analyzed included temperature, measured using a digital thermometer; odor, assessed through the organoleptic method; and Total Dissolved Solids (TDS), measured in mg/L using a TDS meter and compared to the maximum threshold of 300 mg/L set by Permenkes No. 2 Tahun 2023 (Kementerian Kesehatan, 2023). Laboratory testing was conducted in accordance with standard procedures.

This study employed a descriptive observational design with a cross-sectional approach, aiming to assess the physical quality of dug well water based on physical conditions of the wells, septic tank construction, and the distance between wells and septic tanks. The research did not involve group allocation or experimental manipulation. A total of 11 dug wells were selected using purposive sampling, considering their accessibility and the potential risk of contamination based on field observations.

The research was carried out in several stages during the period February to June 2025 in Randuagung Village, Kebomas Subdistrict, Gresik Regency. The first stage involved a preliminary survey to identify the location of wells and septic tanks. This was followed by direct field observation, where researchers recorded the physical condition of each well and the construction details of nearby septic tanks. Distance measurements between wells and septic tanks were conducted using a measuring tape. In the next stage, water samples were taken from each well and brought to the laboratory for physical quality testing, which included measurements of temperature, odor, and Total Dissolved Solids (TDS). All procedures adhered to environmental health standards and were carried out systematically to ensure consistency and accuracy.

All The instruments used in this study included digital thermometer to measure the temperature of water samples, TDS meter to measure Total Dissolved Solids (TDS) in mg/L, measuring tape for calculating the distance between wells and septic tanks, field observation checklists were also used to assess the physical condition of wells and the construction of septic tanks, the organoleptic method was employed to evaluate odor, relying on the sensory perception of trained researchers. All equipment used was standardized and suitable for environmental health fieldwork, although specific brands or validation studies were not mentioned in the article.

Data were collected through a combination of direct observation, structured interviews, and laboratory testing. Observational data were recorded using standard forms based on the SNI 03-2916-1992 for dug wells and SNI 2398:2017 for septic tanks. Interviews with residents provided supporting information about well usage and maintenance. Laboratory tests followed the standards outlined in Permenkes No. 2 Tahun 2023 for physical water quality parameters. The reliability of the field measurements was ensured by repeating measurements and using calibrated instruments, although formal validation results were not stated.

The data analysis was conducted using descriptive statistical methods. The researchers summarized findings in the form of frequencies and percentages, presented through tables that compared the condition of wells, distances to septic tanks, and septic tank construction with the results of water quality tests. No advanced statistical software or inferential analysis techniques were reported in the study. The analysis was focused on identifying trends and patterns to explain the relationship between well and sanitation infrastructure conditions and the physical quality of the water.

## RESULTS AND DISCUSSION

### A. Physical Condition of Dug Wells

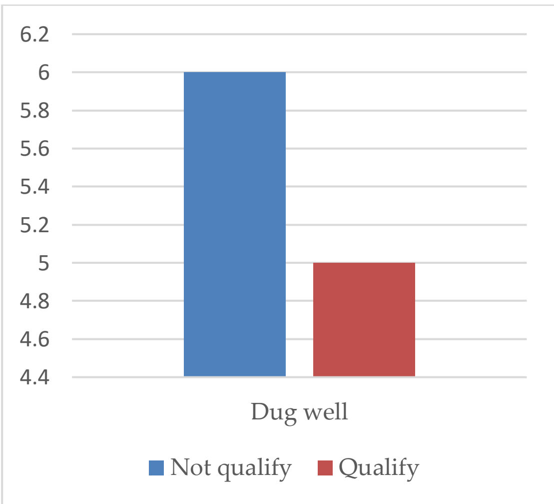


**Figure 1.** Results of the assessment of the physical condition of dug wells

Based on the results of the observation assessment of the physical condition of the dug wells shown in Table 1, it was found that of the 11 wells observed in Randuagung Village, Kebomas Sub-district, Gresik Regency, 5 wells met the requirements and 6 wells did not, indicating that many physical aspects of the wells did not meet sanitation standards. This condition was caused by the poor physical state of the wells, such as unplastered walls, low well lips, and narrow floors. All wells (100%) observed were equipped with lids, which was a positive aspect as lids could prevent dirt, dust, animals, and rainwater from entering the wells. According to the Ministry of PUPR guidelines (2016), an ideal well cap should be made of strong, watertight, and safe materials, ensuring water quality while also preventing accidents around the well.

The quality of dug well construction was significantly associated with the presence of *Escherichia coli* bacteria in water ($p = 0.031$) (Kinasih et al., 2023). The coefficient of determination of 20.2% indicated that the quality of dug well construction influenced the level of microbiological contamination. Wells with walls and floors that were not watertight had a higher risk of pollution from the surrounding environment (Achmad et al., 2020). Especially when the well was positioned lower than pollution sources such as septic tanks, as this increased the potential flow of contaminated water into the well.

## B. Distance between Dug Wells and Septic Tanks

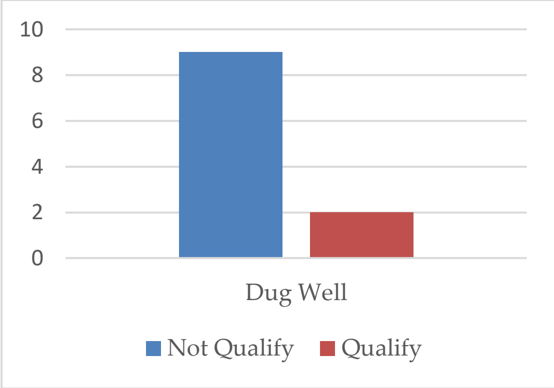


**Figure 2.** Measurement results of the distance between dug wells and septic tanks

Based on field observations of 11 dug wells in Randuagung Village, Kebomas Sub-district, Gresik District, although two wells met the safety distance requirements, the overall average distance from the dug wells to the septic tanks was approximately 7.5 meters. This distance was still below the minimum standard of 10 meters, indicating that most wells in Randuagung Village were constructed too close to septic tanks, and only a few were considered safe from potential contamination.

## C. Septic Tank Construction

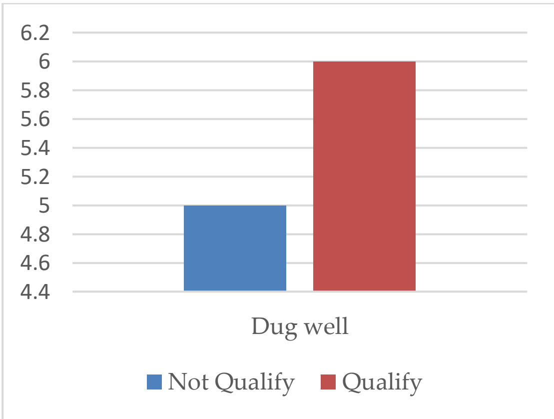


**Figure 3.** Observation Assesment Results of Septic Tank Construction

Based on septic tank construction measurements, it was found that of the 11 wells reviewed, 5 septic tanks (45%) met the requirements, while 6 septic tanks (55%) did not comply with the standards. This condition was not in accordance with the technical guidelines of the 2016 PUPR Ministerial Regulation, which referred to SNI 2398:2017 (SNI, 2017) and required that septic tanks be constructed using waterproof materials (Kementerian Pekerjaan Umum dan Perumahaan Rakyat, 2016).

The walls of the septic tank had to be made from strong and waterproof materials, such as bricks or reinforced concrete, and had to be plastered to seal pores that could cause leakage. The base floor of the septic tank had to be constructed from cast concrete and not from soil or concrete blocks without a protective layer, as direct contact with soil could lead to the infiltration of liquid waste into the surrounding soil layers (Anggraini et al., 2021).

### D. Physical Quality of Dug Well Water

**Table 1**.

Physical quality results of dug well water

| No | Sample | Temperature | TDS mg/l | Odor | Criteria |
|---|---|---|---|---|---|
| 1 | SGL 1 | 27°C | 419 | No odor | not qualify |
| 2 | SGL 2 | 28°C | 535 | No odor | not qualify |
| 3 | SGL 3 | 29°C | 489 | No odor | not qualify |
| 4 | SGL 4 | 29°C | 361 | No odor | not qualify |
| 5 | SGL 5 | 30°C | 405 | No odor | not qualify |
| 6 | SGL 6 | 30°C | 477 | No odor | not qualify |
| 7 | SGL 7 | 29°C | 472 | No odor | not qualify |
| 8 | SGL 8 | 29°C | 643 | odor | not qualify |
| 9 | SGL 9 | 29°C | 571 | odor | not qualify |
| 10 | SGL 10 | 29°C | 399 | No odor | not qualify |
| 11 | SGL 11 | 30°C | 688 | No odor | not qualify |

Based on the results of physical water quality testing of 11 dug well samples in Randuagung Village, Kebomas Sub-district, Gresik Regency, all samples showed unqualified results (TMS). One of the main parameters tested was Total Dissolved Solids (TDS), which, according to Permenkes RI No. 2 of 2023, had a maximum allowable limit of 300 mg/L (Kementerian Kesehatan, 2023). All samples had TDS levels exceeding this limit, ranging from 361 to 688 mg/L.

The physical quality of dug well water was strongly influenced by the construction conditions of the wells. Unplastered walls, impermeable floors, and low well lips allowed surface water to enter the wells. Surface water often carried organic and inorganic particles from the surrounding environment, resulting in increased TDS and turbidity levels in the water. Non-standard well construction contributed to elevated TDS levels (Rinancy & Puteri, 2021).

Dug wells that did not have waterproof construction, such as walls made only from stacked concrete pipes without cement plaster, allowed surface water containing dissolved substances, including minerals, organic matter, and fine particles, to enter the water source. Variations in TDS levels in wells, with recorded values of 176 mg/L, 381 mg/L, and 421 mg/L, were influenced by differences in physical conditions, including construction quality and geographical location (Hamidah & Cindramawa, 2020). Wells with better construction quality and greater distance from pollution sources had lower TDS levels.

**E. Analysis of dug well water quality with well physical condition, distance and septic tank construction**

1. Analysis of physical quality of dug well water by physical condition of wells

**Table 2.**
Analysis of physical quality of dug well water by physical condition of wells

| Physical quality of dug well water | Physical condition of dug well | |
|---|---|---|
| | Qualified | Not Qualify |
| Qualify | 0 | 0 |
| Not Qualify | 5 | 6 |
| Total | 5 | 6 |
| Percentage | 45% | 55% |

Table 2 shows the relationship between the physical condition of wells and the physical quality of dug wells in Randuagung Village. Of the 11 wells analyzed, all (100%) had physical water quality that did not meet the requirements, both in wells with physical conditions that met the standards and those that did not. Forty-five percent of the wells were in good physical condition, while the remaining 55% were in unsatisfactory condition; however, all of them still produced water that did not meet physical standards based on parameters such as odor and TDS.

The physical quality of dug well water was strongly influenced by the physical condition of the wells, including the presence of a well cover, the condition of the apron (floor and rim), the quality of the lining, and well maintenance practices (Astriana, 2018). Wells without covers, with cracked rims, or located in low-lying areas showed increased turbidity and TDS levels, as well as decreased Dissolved Oxygen (DO), with significant differences ($p < 0.05$) (Gnimadi et al., 2024).

In addition, more than 80% of wells were located within 10–30 meters of pollution sources such as residential areas or septic tanks, and 87.5% of wells were not properly maintained or protected. These findings indicated that adequate physical protection of wells was a key factor in maintaining water quality.

2. Analysis of physical water quality of dug wells with distance from septic tank to dug wells

**Table 3.**
Analysis of physical water quality of dug wells with distance from septic tank to dug wells

| Physical Quality of Dug Well Water | Septic Tank Distance to Dug Well | |
|---|---|---|
| | Qualified | Not qualify |
| Qualify | 0 | 0 |
| Not Qualify | 2 | 9 |

| **Physical Quality of Dug Well Water** | **Septic Tank Distance to Dug Well** | |
|---|---|---|
| | **Qualified** | **Not qualify** |
| Total | 2 | 9 |
| Percentage | 18% | 82% |

Table 3 shows that out of 11 dug wells, only 2 wells (18%) had septic tank spacing that met environmental health requirements (≥10 meters). However, despite meeting the ideal distance, both wells still produced water that did not meet the physical requirements. Meanwhile, 9 wells (82%) with septic tank spacing of less than 10 meters also showed inadequate water quality. One important finding was that even wells with appropriate septic tank spacing still experienced physical pollution. This indicated that other environmental factors, such as drainage, rainfall, and soil characteristics, played a major role. These results emphasized that maintaining water quality required attention to multiple technical and environmental aspects, rather than focusing on a single factor.

The results indicated that the distance between septic tanks and dug wells had a more dominant effect on the microbiological quality of water than on its physical quality. A distance that was too close allowed domestic waste containing pathogenic microorganisms, such as *Escherichia coli* and total coliform, to seep through the soil and contaminate water sources. Analysis of 265 monitoring points showed that proximity between septic tanks and wells significantly increased *E. coli* and total coliform concentrations in well water ($p < 0.05$), particularly in densely populated urban areas (Syifa et al., 2025).

Similar findings showed that microbiological contamination was higher in wells located near contamination sources such as septic tanks, compared to those farther away, even when physical water parameters such as color, odor, and temperature were still within acceptable limits (Rusmaya et al., 2022). This confirmed that physical water indicators did not always reflect the presence of harmful microbiological contaminants.

It was concluded that improving the water quality of dug wells required standardized well construction, including plastering the walls, constructing watertight floors, and properly sealing the well. These measures were essential not only to maintain physical and microbiological water quality but also to protect public health from the risk of waterborne diseases such as diarrhea diarrhea (Mulyadi et al., 2018).

3. Physical quality analysis of dug well water with septic tank construction

**Table 2.**

Physical quality analysis of dug well water with septic tank construction

| **Physical quality of dug well water** | **Septic Tank Construction** | |
|---|---|---|
| | **Qualified** | **Not qualify** |
| Qualify | 0 | 0 |
| Not Qualify | 5 | 6 |
| Total | 5 | 6 |
| Percentage | 45% | 55% |

Table 4 shows that of the total 11 dug wells studied, all (100%) had water quality that did not meet the requirements. Based on the construction of the surrounding septic tanks, 5 wells (45%) had septic tanks that met the standards, while the other 6 wells (55%) had septic tanks that did not meet the standards or were not watertight. These results indicated that although some septic tanks were constructed according to standards, this was insufficient to ensure good physical water quality. The physical condition of the wells included non-compliant features, such as unplastered walls, non-watertight structures, and low well rims.

The data showed that the presence of septic tanks did not directly correlate with increases in TDS levels, odor, or water temperature. Two wells with septic tanks at the standard distance still had high TDS levels. This indicated that the physical quality of water was influenced not only by septic tanks but also by other environmental factors. Construction quality of dug wells and their distance from pollution sources, including septic tanks, significantly affected physical parameters such as temperature, pH, turbidity, TDS, and $CaCO_3$, as well as water quality status based on the Pollution Index (PI) (Fitriyah et al., 2022).

Other factors influencing physical water quality included soil type, household activities, topography, and groundwater flow direction. Groundwater contamination was identified as multifactorial and could not be explained by a single technical aspect (Tongu et al., 2024). In the case of Randuagung Village, porous soil characteristics, such as sandy texture, allowed dissolved substances to more easily infiltrate the groundwater layer. Wells constructed near residential drainage systems also showed higher TDS levels, supporting the possibility of wastewater infiltration from the soil surface.

## CONCLUSION

This study showed that physical contamination of dug wells could occur even when the distance from septic tanks was within the standard range. Environmental factors such as drainage, rainfall, and soil characteristics contributed significantly to the decline in water quality. Therefore, pollution control was not sufficient through technical aspects alone but required an integrated environmental sanitation approach. The limitations of this study included the absence of chemical and microbiological parameter analysis, as well as limited consideration of community activities in the surrounding area. Further comprehensive studies were needed to strengthen these findings and to design more effective groundwater management strategies.

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